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EXAMINER	
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	**Application No.** 10/757,507	**Applicant(s)** SCHWOTZER, AXEL	
	Examiner CLIFTON G. DALEY	**Art Unit** 2624	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01 February 2008*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-3, 6-39* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3, 6-39* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *15 January 2004* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

This action is Final. Claims 1-3, and 6-39 are currently pending. Applicant's response received on 2/1/2008 is fully considered herein and is not persuasive.

Drawings

1. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference character(s) not mentioned in the description: Fig. 5, 7. Corrected drawing sheets in compliance with 37 CFR 1.121(d), or amendment to the specification to add the reference character(s) in the description in compliance with 37 CFR 1.121(b) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

2. Claim 26 is objected to because of the following informalities: The language "interlocking method" (paragraph 3, line 1) is not clear in the context of the disclosure. An "interlacing method" is described, but not an "interlocking" method. For purposes of examination, "interlocking method" is taken to be equivalent to "interlacing method". Appropriate correction is required.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claim 15 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The antecedent basis of "the phase related image (P)" (step c4, line 2) is unclear. The limitation could refer to "a phase related image (P)" (step c3, line 2), or "a phase related image (P)" (step c0, line 4). For the purposes of examination, the antecedent basis of "the phase related image (P)" (step c4, line 2) is taken to be "a phase related image (P)" as recited in step c3, line 2.

Claim Rejections - 35 USC § 103

5. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

6. Claims 1-3, 6 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang et al. (hereinafter "Huang": Peisen S. Huang, Qingying Hu, Feng Jin and Fu-Pen Chiang, "Color-encoded fringe projection and phase shifting for 3-D surface contouring", 1998, SPIE, Vol. 3407, pp. 477-482) in view of Joenathan (C. Joenathan, "Phase-measuring interferometry: new methods and error analysis", 1994, Optical Society of America, Vol. 33, No. 19, pp. 4147-4155), and further in view of Wilcock et al. (hereinafter "Wilcock": A. H. Wilcock and R. L. G. Kirsner, "A Digital Filter for Biological Data", 1969, Pergamon Press, Med. & biol. Eng., Vol. 7, pp. 653-660).

Regarding claims 1 and 14, Huang teaches a method and associated device for imaging an object for dental purposes, comprising the steps of:

a) projecting a striped pattern on to the object to be imaged **(Fig. 1, Digital Projector)**,

b) recording the projected striped pattern as a basic image (R.sub.i) with a picture receiver at an angle other than the angle of projection **(Fig. 1, CCD Camera)**, steps a) and b) being carried out at a number of different positions of the phase relation of the striped pattern **(page 479, § 2.2, line 1)**, and

c) computing an image of said object from the plurality of basic camera images that are out-of-phase with each other (R.sub.1 . . . , R.sub.n) **(Fig. 1, 3-D image)**

Huang does not teach the further limitations wherein in order to suppress periodic disturbances, in step c),

c1) recording (n+2) basic images (R.sub.1, R.sub.2 . . . , R.sub.n+2) of which successive basic images show a phase shift.

However, Joenathan discloses a phase measuring interferometry method comprising the step of recording (n+2) basic images (R.sub.1, R.sub.2 . . . , R.sub.n+2) of which successive basic images show a phase shift **(Joenathan: page 4148, Left column, lines 2-9, i.e. n being an integer at least equal to 3)**.

It would have been obvious to one of ordinary skill in the art to have applied Joenathan's imaging steps to Huang's method, the motivation being to reduce noise due to errors or nonlinearities in the projection system **(Joenathan: page 4147, Introduction, lines 19-21)**.

Huang in combination with Joenathan does not teach the limitations of:

c2) forming three groups of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, R.sub.3, . . . , R.sub.n+1; R.sub.3, R.sub.4, . . . , R.sub.n+2),

c3) computing a first phase related image (P1) from the first group of basic images (R.sub.1, R.sub.2, . . . , R.sub.n), a second phase related image (P2) from the second group of basic images (R.sub.2, R.sub.3, . . . , R.sub.n+1), and computing a third phase related image (P.sub.3) from the third group of basic images (R.sub.3, R.sub.4, . . . , R.sub.n+2), and

c4) averaging the first phase related image (P.sub.1) and the third phase related image (P.sub.3) in order to obtain an intermediate image (Pz), and averaging the second phase related image (P.sub.2) and the intermediate image (Pz), in order to obtain a phase related image (P) having a reduced amount of noise, and

computing an image of the object to be imaged from the phase related image (P) having a reduced amount of noise.

However, Wilcock discloses a method for filtering data wherein a first phase related image (P.sub.1) and a third phase related image (P.sub.3) are averaged, in order to obtain an intermediate image (Pz), and a second phase related image (P.sub.2) and the intermediate image (Pz) are averaged, in order to obtain a phase related image (P) having a reduced amount of noise **(page 654, equation 2, i.e. with $A_{-1} = A_1 = ½$ as disclosed at the bottom of the left and top of the right columns)**.

Huang in combination with Joenathan discloses the formation of two groups of basic images and corresponding phase related images **(Joenathan: page 4148, § B, left column, lines 1-2 and right column, lines 5-6 as used in equations 6a and 7a)**.

Therefore, in view of the disclosure of Wilcock above, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have formed a third group of basic images and a third corresponding phase related image (i.e. using well known trigonometric relationships) in order to try the digital filtering

method of Wilcock, the motivation being to reduce the amplitude of high frequency components in the data **(Wilcock: page 653, Introduction, lines 10-12)**.

Summary of Applicant's Remarks: No combination of Huang, Joenathan and Wilcock would result in averaging two groups of basic images and then forming an average of this first average with a third group.

Examiner's Response: Wilcock teaches averaging a series of data **(page 654, equation 2)**. Applying $A_{-1} = A_1 = ½$ **(page 654, bottom of the left and top of the right columns)** in equation 2 results in averaging two data points ($y(t_0 - T)$ and $y(t_0 + T)$) and then forming an average of this first average with a third data point (i.e. $y(t_0)$). Applying the Wilcock method to each pixel in Joenathan's phase related images would therefore result in averaging two groups of basic **(i.e. phase related)** images and then forming an average of this first average with a third group.

Regarding claim 2, Huang in combination with Joenathan and Wilcock, as applied to claim 1 above, teaches a method as defined in claim 1, wherein the computed phase related images (P.sub.1, P.sub.2) are averaged with weighting factors **(Wilcock: page 654, equation 2)**.

Regarding claim 3, Huang in combination with Joenathan and Wilcock, as applied to claim 1 above, teaches a method as defined in claim 1, wherein the basic

images (R.sub.1 . . . , R.sub.m) are each recorded with a constant shift of the phase relation of the lattice (19) **(Joenathan: page 4148, § A, lines 2-3)**.

Regarding claim 6, Huang in combination with Joenathan and Wilcock, as applied to claim 1 above, teaches a method as defined in claim 1, wherein n is 4 **(Joenathan: page 4148, § A, paragraph 1, lines 1-3)**.

7. **Claim 7** is rejected under 35 U.S.C. 103(a) as being unpatentable over Huang combined with Joenathan and Wilcock as applied to claim 1 above, and further in view of Windecker et al. (Hereinafter "Windecker": Robert Windecker and H. J. Tiziani, "Semispatial, robust, and accurate phase evaluation algorithm", 1995, Optical Society of America, Vol. 34, No. 1, pp. 7321-7326).

Huang in combination with Joenathan and Wilcock, as applied to claim 1 above, teaches a method as defined in claim 1.

Huang in combination with Joenathan and Wilcock does not teach the limitation wherein the basic images (R.sub.1, . . . , R.sub.m) are recorded by an interlacing method so that the two fields are out-of-phase with each other.

However, Windecker teaches the limitation wherein the basic images (R.sub.1, . . . , R.sub.m) are recorded by an interlacing method so that the two fields are out-of-phase with each other **(page 7325, right column, lines 12-16)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have applied Windecker's interlacing method to the

imaging method of Huang combined with Joenathan and Windecker, the motivation being to reduce the data acquisition time **(Windecker: page 7325, right column, lines 23-25)**.

8. Claims 8 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang combined with Joenathan and Wilcock, and further combined with Windecker as applied to claim 7 above.

Regarding claim 8, Huang combined with Joenathan, Wilcock and Windecker teaches a method as defined in claim 7, wherein the two fields show a phase shift relative to each other which is equal to half the phase shift between successive basic images (R.sub.1, . . . , R.sub.m) **(Windecker: page 7325, right column, lines 16-19)**.

Regarding claim 9, Huang combined with Joenathan, Wilcock and Windecker teaches a method as defined in claim 7, wherein a phase related image (P.sub.1, P.sub.2) is computed from each of the fields of a basic image (R.sub.1, . . . , R.sub.m) **(Joenathan: page 4148, § B, equations 6b and 7b)** and the two phase related images (P.sub.1, P.sub.2) are averaged prior to further processing in such a manner that a phase related image (P) having a reduced amount of high-frequency noise is formed **(Joenathan: page 4148, § C, lines 1-3)**.

9. **Claim 10** is rejected under 35 U.S.C. 103(a) as being unpatentable over Huang combined with Joenathan and Wilcock as applied to claim 1 above, and further in view of Rubbert et al. (Hereinafter "Rubbert": US 6648640).

Huang in combination with Joenathan and Wilcock teaches a method as defined in claim 1.

Huang in combination with Joenathan and Wilcock does not teach the limitation, wherein prior to step a), an image of a specific test object is recorded and that on the basis of an analysis of the image of the test object a suitable scheme for use in the computation of the noise-reduced phase related image for the object to be imaged is selected.

However, Rubbert teaches a calibration method wherein prior to step a), an image of a specific test object is recorded and that on the basis of an analysis of the image of the test object a suitable scheme for use in the computation of the noise-reduced phase related image for the object to be imaged is selected **(Fig. 8 and column 9, lines 14-16)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have applied Rubbert's calibration method to the method of Huang combined with Joenathan and Wilcock, the motivation being to enable operation of the imaging system without precise knowledge of the optical and mechanical properties of the components **(Rubbert: column 9, lines 19-22)**.

10. Claims 11-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang combined with Joenathan and Wilcock as applied to claim 1 above, and further in view of Brandestini et al. (Hereinafter "Brandestini": US 4837732).

Regarding claim 11, Huang combined with Joenathan and Wilcock teaches a method as defined in claim 1.

Huang combined with Joenathan and Wilcock does not teach the limitation wherein the object to be imaged and a camera used for recording the projected striped pattern can be freely positioned relative to each other.

However, Brandestini teaches a method wherein the object to be imaged and a camera used for recording the projected striped pattern can be freely positioned relative to each other **(Fig. 2)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have made the object and the camera disclosed in the Huang/Joenathan/Wilcock teaching freely positioned relative to each other, the motivation being to allow a user to quickly make changes and verify results **(Brandestini: column 3, lines 6-8)**.

Regarding claim 12, Huang combined with Joenathan and Wilcock teaches a method as defined in claim 1.

Huang combined with Joenathan and Wilcock does not teach the limitation wherein an image of one or more teeth in an oral cavity of a patient is recorded by manual surveying over a short measurement period.

However, Brandestini teaches a method wherein an image of one or more teeth in an oral cavity of a patient is recorded by manual surveying over a short measurement period **(Fig. 1 and column 2, lines 34-36)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have combined Brandestini's teaching with the method of Huang combined with Joenathan and Wilcock, the motivation being to allow a dentist to record the shape in situ of teeth prepared for repair **(Brandestini: Abstract, lines 1-2)**.

Regarding claim 13, Huang combined with Joenathan and Wilcock teaches a method as defined in claim 1, wherein the image to be created of said object is one of a relief image **(Huang: Fig. 3f)**.

Huang combined with Joenathan and Wilcock does not teach the limitation wherein the image to be created of said object is one of a contrast image.

However, Brandestini teaches a method wherein the image to be created of said object is one of a contrast image **(column 9, lines 24-26)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have combined a contrast image with Huang's relief image, the motivation being to improve the efficiency of the system **(Brandestini: column 7, lines 44-50)**.

11. Claims 15-18, 21 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang in view of Joenathan, and further in view of Windecker.

Regarding claims 15 and 26, Huang teaches a method of imaging an object for dental purposes, and analogous device, comprising the steps of:

a) projecting a striped pattern on to the object to be imaged **(Fig. 1, Digital Projector)**,

b) recording the projected striped pattern as a basic image (R.sub.i) with a picture receiver at an angle other than the angle of projection **(Fig. 1, CCD Camera)**, steps a) and b) being carried out at a number of different positions of the phase relation of the striped pattern **(page 479, § 2.2, line 1)**, and

c) computing an image of said object from the plurality of basic camera images that are out-of-phase with each other (R.sub.1 . . . , R.sub.n) **(Fig. 1, 3-D image)**.

Huang does not teach the further limitations wherein in order to suppress periodic disturbances, i.e., noise, in step c),

c1) forming from the basic camera (R.sub.1 . . . , R.sub.m) images at least two groups of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, and R.sub.3, . . . , R.sub.n+1),

c2) computing a phase related image (P.sub.j) of the object to be imaged from each group of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, R.sub.3, . . . , R.sub.n+1)

c3) averaging the computed phase related images (P.sub.1, P.sub.2) such that a phase related image (P) having a reduced amount of noise is formed, and

c4) computing an image of the object to be imaged from the phase related image (P) having a reduced amount of noise.

However, Joenathan discloses a phase measuring method comprising the steps of

c1) forming from the basic camera (R.sub.1 . . . , R.sub.m) images at least two groups of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, and R.sub.3, . . . , R.sub.n+1) **(page 4148, § B, left column, lines 1-2 and right column, lines 5-6 as used in equations 6a and 7a)**,

c2) computing a phase related image (P.sub.j) of the object to be imaged from each group of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, R.sub.3, . . . , R.sub.n+1) **(page 4148, § B, equations 6a and 7a)**

c3) averaging the computed phase related images (P.sub.1, P.sub.2) such that a phase related image (P) having a reduced amount of noise is formed **(page 4148, § C, lines 1-3)**, and

c4) computing an image of the object to be imaged from the phase related image (P) having a reduced amount of noise **(i.e. Huang: Fig. 1, 3D image, after applying Joenathan's steps above)**.

Therefore it would have been obvious to one of ordinary skill in the art to have applied Joenathan's averaging steps to Huang's method, the motivation being to reduce

noise due to errors or nonlinearities in the projection system **(Joenathan: page 4147, Introduction, lines 19-21)**.

Huang combined with Joenathan does not teach a recording method

b1) wherein the basic images (R.sub.1, ..., R.sub.m) are recorded by an interlacing method so that the two fields are out-of-phase with each other.

However, Windecker discloses a phase measuring method

b1) wherein the basic images (R.sub.1, ..., R.sub.m) are recorded by an interlacing method so that the two fields are out-of-phase with each other **(page 7325, right column, lines 12-16)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have substituted Windecker's interlacing method for the imaging method of Huang combined with Joenathan, the motivation being to reduce the data acquisition time **(Windecker: page 7325, right column, lines 23-25)**.

The Huang/Joenathan/Windecker disclosure teaches a noise suppression method

c0) wherein a phase related image (P.sub.1, P.sub.2) is computed from each of the fields of a basic image (R.sub.1 . . . , R.sub.m) **(Joenathan: page 4148, § B, equations 6a and 7a, i.e. each image corresponding to the appropriate field of the Windecker interlace method)** and the two phase related images (P.sub.1, P.sub.2) are averaged prior to further processing in such a manner that a phase related image (P) having a reduced amount of high frequency noise is formed **(page 4148, § C, lines 1-3)**.

Summary of Applicant's Remarks: References do not suggest to "act on each field of a basic image before sampling the basic image".

Examiner's Response: Even if references do not suggest acting on each field of a basic image before sampling the basic image, it is not clear how this is relevant to the instant claim. No limitation recites "sampling the basic image".

Regarding claim 16, Huang in combination with Joenathan and Windecker, as applied to claim 15 above, teaches a method as defined in claim 15, wherein the computed phase related images (P.sub.1, P.sub.2) are averaged with weighting factors **(Windecker: page 7322, equation 10, i.e. weighting factors of ½)**.

Regarding claim 17, Huang in combination with Joenathan and Windecker, as applied to claim 15 above, teaches a method as defined in claim 15, wherein the basic images (R.sub.1 . . . , R.sub.m) are each recorded with a constant shift of the phase relation of the lattice (19) **(Joenathan: page 4148, left column, lines 8-9, "β is the phase step introduced between successive frames.")**.

Regarding claim 18, Huang in combination with Joenathan and Windecker, as applied to claim 15 above, teaches a method as defined in claim 15, including

recording (n+1) basic images (R.sub.1, R.sub.2, . . . , R.sub.n+1) successive basic images showing a phase shift **(Joenathan: page 4148, left column, lines 2-6)**,

forming two groups of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, R.sub.3, . . . , R.sub.n+1) **(Joenathan: page 4148, § B, left column, lines 1-2 and right column, lines 5-6 as used in equations 6a and 7a)**,

computing a first phase related image (P.sub.1) from the first group of basic images (R.sub.1, R.sub.2, . . . , R.sub.n) **(Joenathan: page 4148, § B, equation 6a)** and computing a second phase related image (P.sub.2) from the second group of basic images (R.sub.2, R.sub.3 . . . , R.sub.n+1) **(Joenathan: page 4148, § B, equation 7a)**, and

averaging the first phase related image (P.sub.1) and the second phase related image (P.sub.2) in order to obtain a phase related image (P) having a reduced amount of noise, n being an integer at least equal to 3 **(Joenathan: page 4148, § C, lines 1-3, with n=3, i.e. 4 frames)**.

Regarding claim 21, Huang combined with Joenathan and Windecker teaches a method as defined in claim 15, wherein the two fields show a phase shift relative to each other which is equal to half the phase shift between successive basic images (R.sub.1, . . . , R.sub.m) **(Windecker: page 7325, right column, lines 16-19)**.

12. Claims 19 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang combined with Joenathan and Windecker as applied to claim 15 above, and further in view of Wilcock).

Regarding claim 19, Huang in combination with Joenathan and Windecker, teaches a method as defined in claim 15, including

recording (n+2) basic images (R.sub.1, R.sub.2 . . . , R.sub.n+2), of which successive basic images show a phase shift **(Joenathan: page 4148, Left column, lines 2-9, i.e. n=3)**.

Huang in combination with Joenathan does not teach the limitations of:

forming three groups of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, R.sub.3, . . . , R.sub.n+1; R.sub.3, R.sub.4, . . . , R.sub.n+2),

computing a first phase related image (P1) from the first group of basic images (R.sub.1, R.sub.2, . . . , R.sub.n), a second phase related image (P2) from the second group of basic images (R.sub.2, R.sub.3, . . . , R.sub.n+1), and computing a third phase related image (P.sub.3) from the third group of basic images (R.sub.3, R.sub.4, . . . , R.sub.n+2), and

averaging the first phase related image (P.sub.1) and the third phase related image (P.sub.3) in order to obtain an intermediate image (Pz), and averaging the second phase related image (P.sub.2) and the intermediate image (Pz), in order to obtain a phase related image (P) having a reduced amount of noise.

However, Wilcock discloses a method for filtering data wherein a first phase related image (P.sub.1) and a third phase related image (P.sub.3) are averaged, in order to obtain an intermediate image (Pz), and a second phase related image (P.sub.2) and the intermediate image (Pz) are averaged, in order to obtain a phase related image

(P) having a reduced amount of noise **(page 654, equation 2, i.e. with $A_{-1} = A_1 = ½$ as disclosed at the bottom of the left and top of the right columns)**.

Huang in combination with Joenathan and Windecker discloses the formation of two groups of basic images and corresponding phase related images **(Joenathan: page 4148, § B, left column, lines 1-2 and right column, lines 5-6 as used in equations 6a and 7a)**.

Therefore, in view of the disclosure of Wilcock above, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have formed a third group of basic images and a third corresponding phase related image (i.e. using well known trigonometric relationships) in order to try the digital filtering method of Wilcock, the motivation being to reduce the amplitude of high frequency components in the data **(Wilcock: page 653, Introduction, lines 10-12)**.

Regarding claim 20, Huang in combination with Joenathan, Windecker and Wilcock, teaches a method as defined in claim 19, wherein n is 4 **(Joenathan: page 4148, § A, i.e. 4-bucket method using 4 frames (n=4))**.

13. **Claim 22** is rejected under 35 U.S.C. 103(a) as being unpatentable over Huang combined with Joenathan and Windecker as applied to claim 15 above, and further in view of Rubbert et al. (Hereinafter "Rubbert": US 6648640).

Huang in combination with Joenathan and Windecker teaches a method as defined in claim 15.

Huang in combination with Joenathan and Windecker does not teach the limitation, wherein prior to step a), recording an image of a specific test object and on the basis of an analysis of the image of the test object selecting a suitable scheme for use in the computation of the noise-reduced phase related image for the object to be imaged.

However, Rubbert teaches a calibration method wherein prior to step a), an image of a specific test object is recorded and on the basis of an analysis of the image of the test object a suitable scheme for use in the computation of the noise-reduced phase related image for the object to be imaged is selected **(Fig. 8 and column 9, lines 14-16)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have applied Rubbert's calibration method to the Huang/Joenathan/Windecker method, the motivation being to enable operation of the imaging system without precise knowledge of the optical and mechanical properties of the components **(Rubbert: column 9, lines 19-22)**.

14. Claims 23-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang combined with Joenathan and Windecker as applied to claim 15 above, and further in view of Brandestini et al. (Hereinafter "Brandestini": US 4837732).

Regarding claim 23, Huang combined with Joenathan and Windecker teaches a method as defined in claim 15.

Huang combined with Joenathan and Windecker does not teach the limitation wherein the object to be imaged and a camera used for recording the projected striped pattern can be freely positioned relative to each other.

However, Brandestini teaches a method wherein the object to be imaged and a camera used for recording the projected striped pattern can be freely positioned relative to each other **(Fig. 2)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have made the object and the camera of the Huang/Joenathan/Windecker method freely positioned relative to each other, the motivation being to allow a user to quickly make changes and verify results **(Brandestini: column 3, lines 6-8)**.

Regarding claim 24, Huang combined with Joenathan and Windecker teaches a method as defined in claim 15.

Huang combined with Joenathan and Windecker does not teach the limitation wherein an image of one or more teeth in an oral cavity of a patient is recorded by manual surveying over a short measurement period.

However, Brandestini teaches a method wherein an image of one or more teeth in an oral cavity of a patient is recorded by manual surveying over a short measurement period **(Fig. 1 and column 2, lines 34-36)**.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have combined Brandestini's teaching with the method of Huang

combined with Joenathan and Windecker, the motivation being to allow a dentist to record the shape in situ of teeth prepared for repair **(Brandestini: Abstract, lines 1-2)**.

Regarding claim 25, Huang combined with Joenathan and Windecker teaches a method as defined in claim 15, wherein the image to be created of said object is one of a relief image **(Huang: Fig. 3f)**.

Huang combined with Joenathan does not teach the limitation wherein the image to be created of said object is one of a contrast image.

However, Brandestini teaches a method wherein the image to be created of said object is one of a contrast image **(column 9, lines 24-26)**.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have combined a contrast image with the Huang/Joenathan/Windecker relief image, the motivation being to improve the efficiency of the system **(Brandestini: column 7, lines 44-50)**.

15. Claims 27-30 and 37-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang in view of Joenathan, and further in view of Brandestini.

Regarding claims 27 and 39, Huang teaches a method and associated device of imaging an object for dental purposes, comprising the steps of:

a) projecting a striped pattern on to the object to be imaged **(Fig. 1, Digital Projector)**,

b) recording the projected striped pattern as a basic image (R.sub.i) with a picture receiver at an angle other than the angle of projection **(Fig. 1, CCD Camera)**, steps a) and b) being carried out at a number of different positions of the phase relation of the striped pattern **(page 479, § 2.2, line 1)**, and

c) computing an image of said object from the plurality of basic camera images that are out-of-phase with each other (R.sub.1 . . . , R.sub.n) **(Fig. 1, 3-D image)**.

Huang does not teach the further limitations wherein in order to suppress periodic disturbances in step c),

c1) forming from the basic camera (R.sub.1 . . . , R.sub.m) images at least two groups of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, and R.sub.3, . . . , R.sub.n+1),

c2) computing a contrast image (P.sub.j) of the object to be imaged from each group of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, R.sub.3, . . . , R.sub.n+1)

c3) averaging the computed contrast images (P.sub.1, P.sub.2) such that a contrast image (P) having a reduced amount of noise is formed, and

c4) computing an image of the object to be imaged from the contrast image (P) having a reduced amount of noise.

However, Joenathan discloses the steps of

c1) forming from the basic camera (R.sub.1 . . . , R.sub.m) images at least two groups of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, and R.sub.3, . . . ,

R.sub.n+1) **(page 4148, § B, left column, lines 1-2 and right column, lines 5-6 as used in equations 6a and 7a)**,

c2) computing a phase related image (P.sub.j) of the object to be imaged from each group of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, R.sub.3, . . . , R.sub.n+1) **(page 4148, § B, equations 6a and 7a)**

c3) averaging the computed phase related images (P.sub.1, P.sub.2) such that a phase related image (P) having a reduced amount of noise is formed **(page 4148, § C, lines 1-3)**, and

c4) computing an image of the object to be imaged from the phase related image (P) having a reduced amount of noise **(i.e. Huang: Fig. 1, 3D image, after applying Joenathan's steps above)**.

Therefore it would have been obvious to one of ordinary skill in the art to have applied Joenathan's averaging steps to Huang's method, the motivation being to reduce noise due to errors or nonlinearities in the projection system **(Joenathan: page 4147, Introduction, lines 19-21)**.

Huang combined with Joenathan does not teach the limitation wherein the image to be created of said object is one of a contrast image.

However, Brandestini teaches a method wherein the image to be created of said object is one of a contrast image **(column 9, lines 24-26)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have combined a contrast image with Huang's relief

image, the motivation being to improve the efficiency of the system **(Brandestini: column 7, lines 44-50)**.

Summary of Applicant's Remarks: Although Brandestini teaches the use of a contrast image, it is not known to use the method of claim 1 to create a contrast image with a reduced amount of noise.

Examiner's Response: Applicant appears to be referring to **original** claim 1. While Brandestini does not use the method of original claim 1 to create a contrast image with a reduced amount of noise, Brandestini clearly suggests creating contrast images using the same data used to generate phase images **(column 11 lines 37 to 47)**. Since the Huang/Joenathan combination teaches a method (original claim 1) of using multiple phase shifted images to produce a phase related image having a reduced amount of noise, it would be obvious to one of ordinary skill in the art to create Brandestini's contrast images from the same set of data in order to create a contrast image having a reduced amount of noise.

Regarding claim 28, Huang in combination with Joenathan and Brandestini, teaches a method as defined in claim 27, wherein the computed phase related images (P.sub.1, P.sub.2) are averaged with weighting factors **(Joenathan: page 4148, § C, lines 1-3, i.e. weighting factors of ½ as understood by the common meaning of the term "average")**.

Regarding claim 29, Huang in combination with Joenathan and Brandestini, teaches a method as defined in claim 27, wherein the basic images (R.sub.1 . . . , R.sub.m) are each recorded with a constant shift of the phase relation of the lattice (19) **(Joenathan: page 4148, left column, lines 8-9, "β is the phase step introduced between successive frames.")**.

Regarding claim 30, Huang in combination with Joenathan and Brandestini, teaches a method as defined in claim 27, including

recording (n+1) basic images (R.sub.1, R.sub.2, . . . , R.sub.n+1) successive basic images showing a phase shift **(Joenathan: page 4148, left column, lines 2-6)**,

forming two groups of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, R.sub.3, . . . , R.sub.n+1) **(Joenathan: page 4148, § B, left column, lines 1-2 and right column, lines 5-6 as used in equations 6a and 7a)**,

computing a first phase related image (P.sub.1) from the first group of basic images (R.sub.1, R.sub.2, . . . , R.sub.n) **(Joenathan: page 4148, § B, equation 6a)** and computing a second phase related image (P.sub.2) from the second group of basic images (R.sub.2, R.sub.3 . . . , R.sub.n+1) **(Joenathan: page 4148, § B, equation 7a)**, and

averaging the first phase related image (P.sub.1) and the second phase related image (P.sub.2) in order to obtain a phase related image (P) having a reduced amount

of noise, n being an integer at least equal to 3 **(Joenathan: page 4148, § C, lines 1-3, i.e. 3-bucket method)**.

Regarding claim 37 Huang combined with Joenathan and Brandestini teaches a method as defined in claim 27, wherein the object to be imaged and a camera used for recording the projected striped pattern can be freely positioned relative to each other **(Brandestini: Fig. 2)**.

Regarding claim 38, Huang combined with Joenathan and Brandestini teaches a method as defined in claim 27, wherein an image of one or more teeth in an oral cavity of a patient is recorded by manual surveying over a short measurement period **(Brandestini: Fig. 1 and column 2, lines 34-36)**.

16. Claims 31 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang combined with Joenathan and Brandestini as applied to claim 27 above, and further in view of Wilcock).

Regarding claim 31, Huang in combination with Joenathan and Brandestini, teaches a method as defined in claim 27, including

recording (n+2) basic images (R.sub.1, R.sub.2 . . . , R.sub.n+2), of which successive basic images show a phase shift **(Joenathan: page 4148, Left column, lines 2-9, i.e. n=3)**.

Huang in combination with Joenathan and Brandestini does not teach the limitations of:

forming three groups of basic images (R.sub.1, R.sub.2, . . . , R.sub.n; R.sub.2, R.sub.3, . . . , R.sub.n+1; R.sub.3, R.sub.4, . . . , R.sub.n+2),

computing a first phase related image (P1) from the first group of basic images (R.sub.1, R.sub.2, . . . , R.sub.n), a second phase related image (P2) from the second group of basic images (R.sub.2, R.sub.3, . . . , R.sub.n+1), and computing a third phase related image (P.sub.3) from the third group of basic images (R.sub.3, R.sub.4, . . . , R.sub.n+2), and

averaging the first phase related image (P.sub.1) and the third phase related image (P.sub.3) in order to obtain an intermediate image (Pz), and averaging the second phase related image (P.sub.2) and the intermediate image (Pz), in order to obtain a phase related image (P) having a reduced amount of noise.

However, Wilcock discloses a method for filtering data wherein a first phase related image (P.sub.1) and a third phase related image (P.sub.3) are averaged, in order to obtain an intermediate image (Pz), and a second phase related image (P.sub.2) and the intermediate image (Pz) are averaged, in order to obtain a phase related image (P) having a reduced amount of noise **(page 654, equation 2, i.e. with $A_{-1} = A_1 = ½$ as disclosed at the bottom of the left and top of the right columns)**.

Huang in combination with Joenathan and Brandestini discloses the formation of two groups of basic images and corresponding phase related images **(Joenathan: page 4148, § B, left column, lines 1-2 and right column, lines 5-6 as used in equations 6a and 7a)**.

Therefore, in view of the disclosure of Wilcock above, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have formed a third group of basic images and a third corresponding phase related image (i.e. using well known trigonometric relationships) in order to try the digital filtering method of Wilcock, the motivation being to reduce the amplitude of high frequency components in the data **(Wilcock: page 653, Introduction, lines 10-12)**.

Regarding claim 32, Huang in combination with Joenathan, Brandestini and Wilcock, teaches a method as defined in claim 19, wherein n is 4 **(Joenathan: page 4148, § A, i.e. 4-bucket method using 4 frames (n=4))**.

17. Claims 33-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang in view of Joenathan and Brandestini, and further in view of Windecker.

Regarding claim 33, Huang combined with Joenathan and Brandestini teaches the method as defined in claim 27.

Huang combined with Joenathan and Brandestini does not teach the method including recording the basic images (R.sub.1, ..., R.sub.m) by an interlacing method so that the two fields are out-of-phase with each other.

However, Windecker discloses a phase measuring method wherein the basic images (R.sub.1, ..., R.sub.m) are recorded by an interlacing method so that the two fields are out-of-phase with each other **(page 7325, right column, lines 12-16)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have substituted Windecker's interlacing method for the imaging method of Huang combined with Joenathan and Brandestini, the motivation being to reduce the data acquisition time **(Windecker: page 7325, right column, lines 23-25)**.

Regarding claim 34, Huang combined with Joenathan, Brandestini and Windecker teaches a method as defined in claim 33, wherein the two fields show a phase shift relative to each other which is equal to half the phase shift between successive basic images (R.sub.1, . . . , R.sub.m) **(Windecker: page 7325, right column, lines 16-19)**.

Regarding claim 35, Huang combined with Joenathan, Brandestini and Windecker teaches a method as defined in claim 33, wherein a contrast image (P.sub.1, P.sub.2) is computed from each of the fields of a basic image (R.sub.1, . . . , R.sub.m) **(Joenathan: page 4148, § B, equations 6b and 7b, applying Brandestini's method to replace the Joenathan's phase related images with the Brandestini's contrast images)** and the two contrast images (P.sub.1, P.sub.2) are averaged prior to further processing in such a manner that a contrast image (P) having a reduced amount of high frequency noise is formed **(Joenathan: page 4148, § C, lines 1-3)**.

18. **Claim 36** is rejected under 35 U.S.C. 103(a) as being unpatentable over Huang combined with Joenathan and Brandestini as applied to claim 27 above, and further in view of Rubbert.

Huang in combination with Joenathan and Brandestini teaches a method as defined in claim 27.

Huang in combination with Joenathan and Brandestini does not teach the limitation, wherein prior to step a), recording an image of a specific test object and on the basis of an analysis of the image of the test object selecting a suitable scheme for use in the computation of the noise-reduced contrast image for the object to be imaged.

However, Rubbert teaches a calibration method wherein prior to step a), an image of a specific test object is recorded and that on the basis of an analysis of the image of the test object a suitable scheme for use in the computation of the noise-reduced contrast image for the object to be imaged is selected **(Fig. 8 and column 9, lines 14-16)**.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have applied Rubbert's calibration method to the method of Huang combined with Joenathan and Brandestini, the motivation being to enable operation of the imaging system without precise knowledge of the optical and mechanical properties of the components **(Rubbert: column 9, lines 19-22)**.

Conclusion

19. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to CLIFTON G. DALEY whose telephone number is 571-270-3144. The examiner can normally be reached on Monday - Friday 7:30am - 4:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samir Ahmed can be reached on 571-272-7413. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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